AMERICAN MUSEUM OF NATURAL HISTORY

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EXTINCT OTTER-LIKE 'MARINE BEAR' MIGHT HAVE HAD A BITE LIKE A SABER-TOOTHED CAT

BIOMECHANICAL MODELING SUGGESTS THAT *KOLPONOMOS* LIKELY USED ANCHOR-BITING TO PRY HARD-SHELLED INVERTEBRATES

New research suggests that the feeding strategy of *Kolponomos*, an enigmatic shell-crushing marine predator that lived about 20 million years ago, was strangely similar to a very different kind of carnivore: the saber-toothed cat *Smilodon*. Scientists at the American Museum of Natural History used high-resolution x-ray imaging and computerized biting simulations to show that even though the two extinct predators likely contrasted greatly in food preference and environment, they shared similar engineering in jaw structure, suitable for anchoring against prey with the lower jaw and forcefully throwing the skull forward to pry loose its food. The study is published today in the journal *Proceedings of the Royal Society B*.

The only known specimens of *Kolponomos*—primarily skulls and teeth of two species—were recovered from ancient marine deposits along the Pacific coast of Oregon, Washington, and possibly Alaska. Because of its peculiar morphology and the small number of fossils, the animal's place in the evolutionary tree remains a mystery.

"When *Kolponomos* was first described in the 1960s, it was thought to be a raccoon relative," said Camille Grohé, a National Science Foundation and Frick Postdoctoral Fellow in the American Museum of Natural History's Division of Paleontology and a co-author on the new paper. "But later research on the skull base led some to think it might be a seal or a bear relative instead, and studies of its teeth show that they are very similar in both shape and wear to the teeth in sea otters."

Sea otters pry their prey—hard-shelled marine invertebrates like clams and mussels—off of surfaces using their hands and rock tools, then crush the shells with their

teeth or against their chests, again using tools. By studying *Kolponomos* fossil material from the National Museum of Natural History in Washington, D.C., and comparative specimens from the American Museum of Natural History, the research team originally set out to test if the extinct predator used otter-like shell-crushing to eat. But the scope of the research expanded after Grohé's collaborator Z. Jack Tseng noticed something curious in parallel to work he was conducting on the saber-toothed cat *Smilodon*.

"I started seeing a great deal of similarity between the jaws of *Kolponomos* and *Smilodon*," said Tseng, a National Science Foundation and Frick Postdoctoral Fellow in the American Museum of Natural History's Division of Paleontology and the lead author on the new paper. "Both of them have a distinctive profile with a deep jaw bone that tapers off toward the back, and both have an expansion of the mastoid processes and the skull's back surface, suggesting large attachment sites for muscles that let the animal move its head powerfully but with control. We definitely didn't expect to bring *Smilodon* into this study of feeding in a clam-eating marine carnivore, but that's what we ended up doing."

At the Museum's Microscopy and Imaging Facility, the researchers used computed tomography (CT) to scan the skulls of *Kolponomos* and six other carnivores: *Smilodon*, grey wolf, sea otter, river otter, brown bear, and leopard. They then used computerized methods to build sophisticated biomechanical models to look at how efficiently the animals could perform various bites, including the jaw-anchored killing shear-bite that is characteristic of saber-tooth cats.

They found that the jaw mechanics of *Kolponomos* and *Smilodon* are more similar to each other than to any of the other animals in the study, pointing to a unique feeding strategy in addition to the previous idea that *Kolponomos* might have crushed its prey like sea otters do today. Taken together, the researchers suggest that *Kolponomos* might have pried prey off of rocks with its lower jaw, swung its skull forward to dislodge it, and then crunched it with its chewing teeth.

"Our biomechanical data show that the chewing bites of sea otters and *Kolponomos* are not very similar," Tseng said. "They probably still have an overlapping diet based on tooth wear, but their evolutionary solutions for getting to those hard-shelled animals are dramatically different."

The researchers stress that this finding does not imply shared ancestry between

Kolponomos and *Smilodon*, but rather an intriguing case of convergence—the independent evolution of similar traits.

"This innovative study, showing unexpected feeding similarities between such wildly distinct carnivores, could only happen by applying new technologies to understand specimens from some of the world's greatest archives of ancient life," said John J. Flynn, a curator in the Museum's Division of Paleontology and Dean of the Richard Gilder Graduate School, also an author on this paper.

This work was funded by the U.S. National Science Foundation grant # DEB-1257572 and the American Museum of Natural History's Frick Postdoctoral Fellowships.

The authors have dedicated this study to the memory of Museum artist Chester Tarka, who illustrated *Kolponomos newportensis*. Tarka, a decorated Army veteran of the Normandy Invasion and Battle of the Bulge in WWII, passed away recently at the age of 96 and was buried with military honors in Saratoga, New York.

AMERICAN MUSEUM OF NATURAL HISTORY (AMNH.ORG)

The American Museum of Natural History, founded in 1869, is one of the world's preeminent scientific, educational, and cultural institutions. The Museum encompasses 45 permanent exhibition halls, including the Rose Center for Earth and Space and the Hayden Planetarium, as well as galleries for temporary exhibitions. It is home to the Theodore Roosevelt Memorial, New York State's official memorial to its 33rd governor and the nation's 26th president, and a tribute to Roosevelt's enduring legacy of conservation. The Museum's five active research divisions and three cross-disciplinary centers support approximately 200 scientists, whose work draws on a world-class permanent collection of more than 33 million specimens and artifacts, as well as specialized collections for frozen tissue and genomic and astrophysical data, and one of the largest natural history libraries in the world. Through its Richard Gilder Graduate School, it is the only American museum authorized to grant the Ph.D. degree and, beginning in 2015, the Master of Arts in Teaching degree, which began as a pilot in 2012 and is the only non-university affiliated such program in the United States. Annual attendance has grown to approximately 5 million, and the Museum's exhibitions and Space Shows can be seen in venues on five continents. The Museum's website and collection of apps for mobile devices extend its collections,

exhibitions, and educational programs to millions more beyond its walls. Visit amnh.org for more information.

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No. 23